

Providing Field Support for the Behavior Response Study (BRS-07)

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LONG-TERM GOALS

The long-term goals of this project are to contribute towards the development of a science-based sonar use policy for the US Navy which reduces the risk of injury to beaked whales from mid-frequency sonar. This project will also increase our understanding of the population and behavioral ecology of beaked whales and will contribute towards the assessment of impacts of naval activities at the Atlantic Undersea Test and Evaluation Center (AUTEC).

OBJECTIVES

The over-riding objective of this effort is to provide field support for Phase I of the Behavior Response Study (BRS). Specific objectives are:

- 1) To work with the Marine Mammal Monitoring (M3R) program at AUTEC to visually locate cetaceans detected acoustically on the AUTEC range, with a particular focus on finding beaked whales (Family *Ziphiidae*).
- 2) To photo-identify individual animals within each group found.
- 3) To attach digital acoustic tags or Dtags to beaked whales and pilot whales to prepare for playback experiments and to gather baseline data on the diving behavior of these species in Tongue of the Ocean (TOTO).
- 4) To conduct focal follows of the tagged whale before, during and after a playback experiment.
- 5) To conduct aerial surveys for stranded or injured cetaceans before BRS started, following each playback and after BRS ended, as part of the BRS mitigation.
- 6) To provide a team from a Bahamian non-governmental organization to allow independent observation of the experiment.

APPROACH

The Behavior Response Study is a large, multi-national project in which responses of whales exposed to underwater sounds are measured to identify and mitigate their adverse effects. The first phase of this project (known as BRS-07) took place during August and September 2007 at the US Navy's AUTEC range in the Bahamas. Whales were located using AUTEC's 82-hydrophone fixed array with the M3R acoustic detection program and by visual searches with observers aboard 2 different vessels. Once a

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group was located, individuals were photo-identified to ensure that playback criteria were satisfied (i.e. individuals had not been previously exposed and there were no calves in the group). If criteria were met, attempts were made to attach a Dtag to one or more individuals within the group. Focal follows of the tagged whales were conducted before, during and after the playback. The tagged whales were also tracked by using a radio direction finder during daylight hours and through the night. When the tag's suction cups released, the tag was retrieved and the data collected were downloaded. Preliminary analysis of the photo-identification, focal follow and tag data was done immediately to contribute towards a Quick Look report which was provided to the Chief Scientist as soon as possible.

To successfully complete this sequence of events required a team of 35 people, eight of whom were from the Bahamas Marine Mammal Research Organization (BMMRO). BMMRO also provided a 29-foot (9.5 m) Blackfin ocean cruiser, equipped with 2-225 Hp four-stroke outboard engines, which was used for photo-identification and focal follows. The 11-foot (3.6 m) tagging boat was carried on deck and launched when tagging attempts were deemed feasible. A second BMMRO vessel, RHIB 18, was used opportunistically for photo-identification whilst on transit between the AUTECH base and *Ranger*, the source vessel.

When weather permitted, the Blackfin departed AUTECH Site 1 and was vectored by M3R to locations where beaked whales were detected acoustically. The number of observers on board the Blackfin ranged from 5 – 9 but averaged 8 throughout the field effort. This included the tagging team, as well as a Bahamas Fisheries Officer and various guests throughout the test. Key personnel included Diane Claridge (Blackfin captain, BMMRO), Charlotte Dunn (primary photo-id, BMMRO) and a data recorder, Olivia Patterson (BMMRO, weeks 1-3) and Dr. Nicola Quick (Sea Mammal Research Unit (SMRU), weeks 4-6). The tagging team consisted of Alex Bocconcelli (tag boat captain, Woods Hole Oceanographic Institute (WHOI)), Leigh Hickmott (primary tagger, BMMRO), Dr. Ari Friedlander (tagger and photo-id, Duke University), Mari Quero (data recorder) and 5 different tag technicians throughout the field effort. Focal follows were conducted by all personnel aboard the vessel.

Additionally, BMMRO coordinated and conducted aerial surveys of the coastal areas in search of stranded animals before, during and after BRS tests. Flights were conducted based on differing objectives at the time including pre-BRS surveys, mitigation flights following playbacks and searching for tags. The focus of all mitigation flights was to search the shoreline along the eastern coast of Andros Island, but searches also included the small islands in North and Middle Bights, the bank edge and cays along the east side of Tongue of the Ocean (TOTO), and the coastal areas of New Providence Island. Aircraft used included an AUTECH helicopter, an Aerocommander and a Cessna 182. All flights were flown at an altitude of 500 feet and at an average speed of 90 knots, with the exception of the helicopter survey which was flown at 200 feet and at 130 knots.

The Bahamas Marine Mammal Research Organization (BMMRO) is a registered Bahamian not-for-profit organization. As such, BMMRO served an additional role during BRS-07 as an independent observer group monitoring the experiment. In addition to the team on the Blackfin, BMMRO personnel worked with the M3R team in the Command Control Building and three visual observers were placed on board the source vessel to observe the response of beaked whales and other cetaceans to the sound source produced during the playback experiment. Following each playback event, BMMRO staff convened to review the observations made by each staff member at their particular station.

WORK COMPLETED

During BRS-07, the Blackfin had 18 days at sea from (15 August – 21 September), during which the Blackfin was vectored to locations by M3R. This effort covered 1188 nm (2198 km) and over 100 hours of time searching for whales (Figure 1, on left). Vessel effort was focused on the northern and western portion of the AUTC range and in particular around “Whiskey 2”, one of the smaller arrays on Weapons Range North, where beaked whales were frequently detected.

There were 32 cetacean sightings made by observers on board the Blackfin and RHIB 18 during BRS-07. All sightings with the exception of the sightings of Atlantic bottlenose dolphin (*Tursiops truncatus*), occurred in water depths greater than 1000m and were concentrated in depths greater than 1500m (Figure 1, on right). In all, 49.1 hours was spent with animals during sightings conducting photo-id, focal follows, tagging attempts and radio-tracking of tagged whales. During this time, over 38 hours of focal follow data were collected, including respiration rates and surfacing behavior.

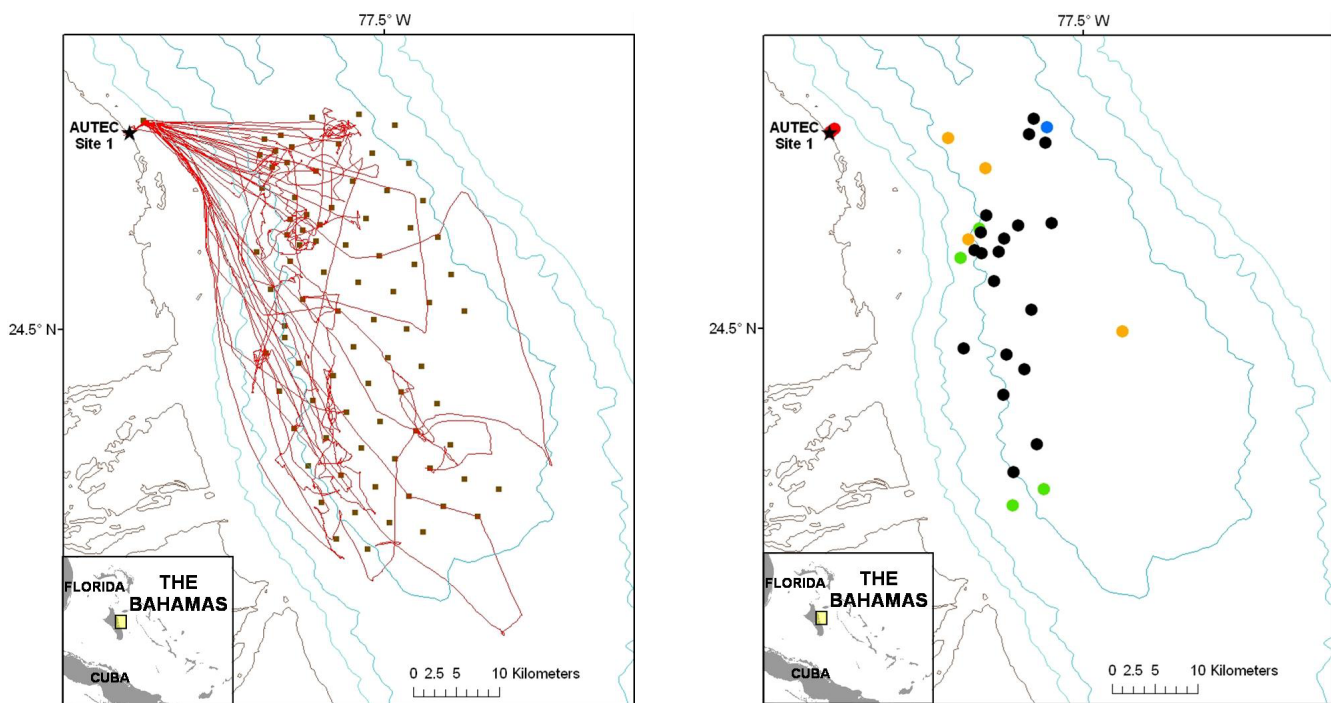


Figure 1. Vessel tracks for the Blackfin (map on left) during BRS-07, with the locations of the AUTC hydrophones shown by the brown squares. The Blackfin operated daily from AUTC Site 1 and the majority of survey effort was on the northern and western side of the range. The map on the right shows the locations where cetaceans were sighted, where black circles represent Blainville's beaked whale sightings, green represent short-finned pilot whales, blue represent pygmy sperm whales, red represent Atlantic bottlenose dolphins and orange represent unidentified species. The 500m isobaths are shown.

The primary target species, Blainville's beaked whales (*Mesoplodon densirostris*), were sighted 19 times, representing 59% of all sightings. Short-finned pilot whales (*Globicephala macrorhynchus*), a secondary target species, were seen on 4 occasions. Other species sighted include pygmy sperm whales (*Kogia breviceps*) which were seen once and Atlantic bottlenose dolphins (*Tursiops truncatus*) which

were sighted on 4 occasions inside or near the AUTEC harbor, and there were 4 distant sightings during which the species could not be determined. A total of 219 animals were seen, including at least 23 juveniles or calves. When cetaceans were sighted, close approaches were made whenever possible in order to photograph all individuals in the group. We successfully obtained photographs of 45 of the 50 beaked whales seen and all of the bottlenose dolphins. Analysis of the photographs taken of the pilot whales has not yet been undertaken but it is estimated that we photo-identified approximately 80% of the whales seen.

A primary component of the BRS-07 experiment plan involved attaching a Dtag to individual Blainville's beaked whales and short-finned pilot whales prior to exposing the whale to the sound source (Figure 2). This work was carried out by BMMRO personnel working alongside personnel from WHOI, with equipment and technical support provided by WHOI. During BRS-07, six Dtags were deployed on Blainville's beaked whales and 4 on short-finned pilot whales. The beaked whale tags were placed on 2 adult males and 4 adult females and 71 hours of data were recorded with four 17-hour deployments. Thirty-five hours of data were recorded from 4 Dtag deployments on short-finned pilot whales which were placed on adult and subadult males. Skin and blood samples were collected from 8 whales (5 beaked whales and 3 pilot whales) from the suction cups on the Dtag when the tag was recovered.



Figure 2. Blainville's beaked whale with Dtag placed posterior to the blowhole.

Seven aerial surveys were flown during BRS-07, totaling 19.5 hours of flight time and covering 1778 nm (3287 km) during the period. The flight tracks from each of the surveys are shown in Figure 3. Two flights were made before the BRS experiment began, one of which was in the AUTEC helicopter. There were two mitigation flights following the pilot whale playback experiment: the first covered the playback area and the whale's path following the playback; and the second flight surveyed the entire eastern coastline of Andros Island. There were also two mitigation flights following the beaked whale playback which allowed a thorough search of the Andros and New Providence coastlines and the eastern side of TOTO. Cetacean species sighted during the aerial surveys included 3 groups of Atlantic bottlenose dolphins and one group of rough-toothed dolphins (*Steno bredanensis*), and no stranded or injured animals were found. Sightings of sharks, sea turtles and rays were also recorded during flights.

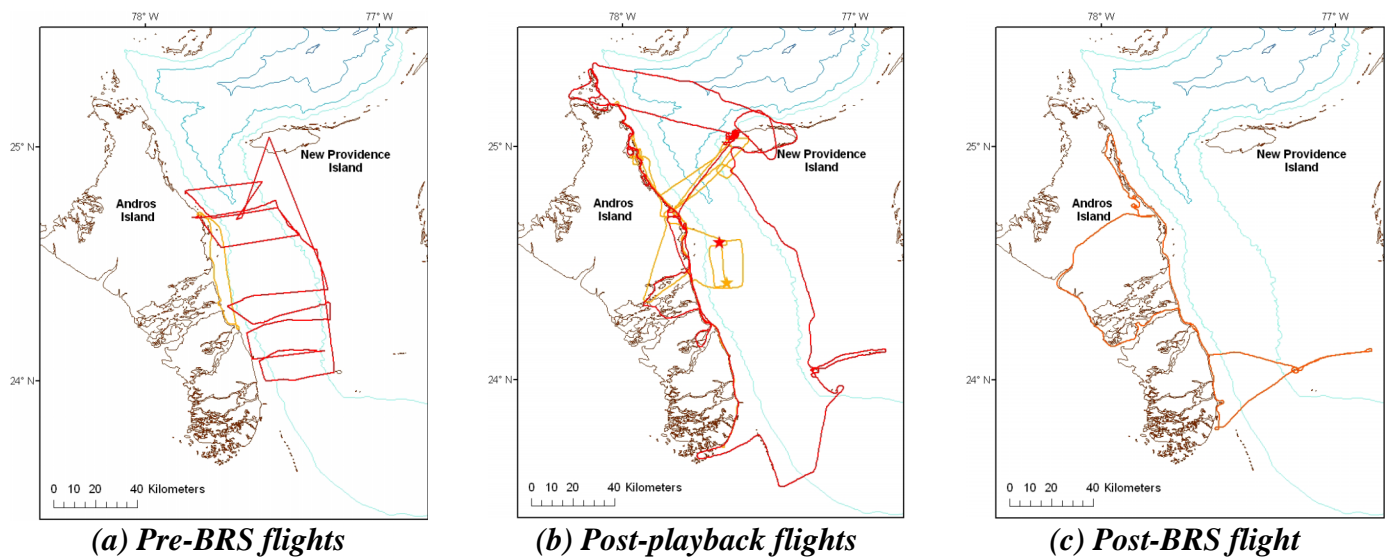


Figure 3. Map of Tongue of the Ocean showing the aerial surveys flown during BRS-07. Map (a) shows tracks of the 2 flights flown before BRS began. The first flight (in orange) was along the east coast of Andros Island and the second flight (in red) covered the waters of Tongue of the Ocean. Map (b) shows tracks of the post-playback mitigation flights. The orange asterisk represents the location of the pilot whale playback experiment and the orange track lines show the mitigation flights on the northern part of the range and the Andros coastline following the playback. The red asterisk represents the location of the beaked whale playback experiment and the red track lines show the mitigation flights along the Andros and New Providence coastlines and the eastern side of TOTO. Map (c) shows tracks of the flight after BRS ended. The 1000m isobaths are shown.

RESULTS

Blainville's beaked whales were regularly sighted on the AUTECH range during BRS-07 and appear to be one of the most frequently occurring species in the Tongue of the Ocean (TOTO). The mean group size was 2.5 whales (range 1 – 6, mode 2, median 2) and all age classes were found. Short-finned pilot whales were not sighted as frequently and were found transiting through the range. They were found in much larger groups, ranging from 30 – 40 whales.

Preliminary analysis of over 2,000 identification photographs taken during BRS-07 showed that there were 30 individual Blainville's beaked whales identified by their unique scarring patterns. Although the majority of individuals were only photographed once, there were 5 whales seen twice and 5 whales seen three times. Eight whales matched to BMMRO's existing photo-identification catalogue for TOTO from 2005 and 2006 (Figure 4). These results suggest that there is residency in the area by some whales.



Figure 4. Identification photographs of an adult male Blainville's beaked whale (Md517) which was first photographed by BMMRO in Tongue of the Ocean in March 2006 (on top) and seen 3 times during BRS-07 (on bottom). Despite increased scarring which occurred between the two dates shown, Md517 is readily recognized by the notch in the leading edge of the dorsal fin and the unique pattern of intraspecific linear scars and the oval cookie cutter shark scars.

Important baseline or control data were collected from 5 Dtags deployed on Blainville's beaked whales during BRS-07. These data provided a comparison with data that were recorded from the tagged whale exposed to mid-frequency active (MFA) sonar and killer whales calls during the playback experiment. The four long tag deployments also provided valuable information on the foraging behavior of Blainville's beaked whales in TOTO (e.g. Figure 5). These data are also extremely useful for M3R to improve software to localize individual beaked whales by echolocation clicks detected by the AUTECH hydrophone array.

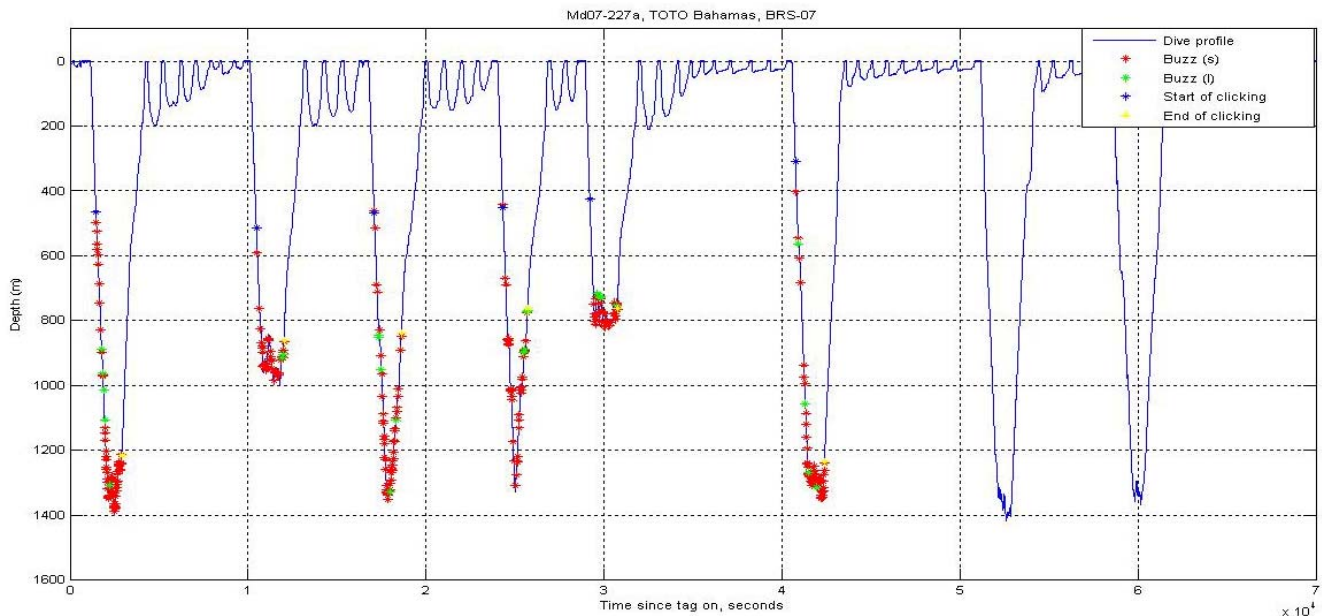


Figure 5. Dive profile from the first Blainville's beaked whale which was tagged on 15 August 2007. During the 18 hour deployment, the whale made seven deep foraging dives reaching depths of 1400m. This tag provided important baseline (control) data for comparison to the whale that was later exposed to MFA sonar and killer whale calls.

IMPACT/APPLICATIONS

Mass strandings of beaked whales in several areas (e.g. Simmonds and Lopez-Juraco 1991, Frantzis 1998, Jepson *et al.* 2003), including the northern Bahamas (Balcomb and Claridge 2001, NOAA 2001) have correlated with international naval operations, raising concern that beaked whales are particularly vulnerable to anthropogenic noise. Findings during BRS-07 will help to address these concerns in numerous ways. In addition to learning about the behavioral response of beaked whales and pilot whales to MFA sonar and killer whale calls during the playback experiment, we have also gathered important baseline data on their diving behavior, which will help with interpreting the results as well as elucidate information on the diving physiology of beaked whales and their foraging ecology. Equally important, we have also increased our understanding of the occurrence and residency patterns of beaked whales on the AUTEK range which will help assess current mitigation on the range and contribute much needed data for environmental reviews.

Mid-frequency active sonar is regularly used during tests on the AUTEK range, including two to three 53C sonar tests annually. With resident Blainville's beaked whales utilizing the range for foraging, it is important that the Navy ensure that their current mitigation is effective. The photo-identification data collected during BRS-07, when combined with data to be collected during BRS-08, will allow us to monitor the population status of beaked whales on the range. This 2-year sampling period will allow us to estimate abundance and rates of immigration and emigration of Blainville's beaked whales in Tongue of the Ocean to more thoroughly examine residency patterns and site fidelity. The photographic data and tissue samples collected will also contribute to a population structuring study currently being conducted on a larger scale, in the Great Bahama Canyon (TOTO forms the southern branch of this submarine canyon) to assess the relationship of beaked whales in TOTO to stocks identified elsewhere in the northern Bahamas.

RELATED PROJECTS

Behavior Response Study (BRS)

The goal of this project is to understand how cetaceans respond to underwater sound. This international study is led by Dr. Ian Boyd (SMRU) as the Chief Scientist and holder of Bahamian research permit, and the Principal Investigator and holder of US permit was Dr. Brandon Southall (National Oceanographic and Atmospheric Administration (NOAA)). The project is supported by the Office of Naval Research (ONR) and US Department of Defense (NAVSEA PEO IWS Mr. Joseph Johnson and OPNAV N45 Dr. Frank Stone).

Distribution, abundance and population structuring of beaked whales in the Great Bahama Canyon, northern Bahamas.

The goals of this project are to determine beaked whale distribution and abundance in the Great Bahama Canyon (Northeast and Northwest Providence Channels and Tongue of the Ocean) from visual and acoustic surveys. The study is also examining population structure of beaked whales in the Great Bahama Canyon through the analysis of photo-identification data and genetic samples currently archived by BMMRO and from photographs and biopsy samples obtained during the surveys. The project is funded by an ONR grant (FY07 – FY10) and Diane Claridge (BMMRO) is the Principal Investigator and Dr. John Durban (NOAA) is the co-Principal Investigator. Dr. Jonathan Gordon (SMRU) is running the acoustic surveys with funding from the UK's Defence Science and Technology Laboratory.

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